Filling the Data Gap on Responses of Fish PCB Content to Remedial Actions in Torch Lake, Michigan

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Introduction

Michigan Technological University is located within Ojibwa (Chippewa) homelands and ceded-territory established by the Treaty of 1842, the shared lands and waters of 11 Member Native American nations. In this land, tribal members have the right to fish and harvest from Lake Superior and the surrounding Watersheds.

Polychlorinated biphenyls are persistent, bioaccumulative, and toxic compounds that accumulate in the lipid tissue of biological organisms such as Walleye, which are of cultural, commercial, and nutritional importance to tribal members and fishermen.

Organic toxics such as PCBs inhibit the safe consumption of these fish, as PCBs cause enzyme upregulation, reproductive toxicity, cancers, immune suppression, decreased cognition.

1830
Ojibwe fishing grounds

1910-1930
Copper Mills and Power Plant Constructed, releasing stamp sand containing heavy-metals

1940 – 1968
Copper Scrap reclamation combusts PCBs

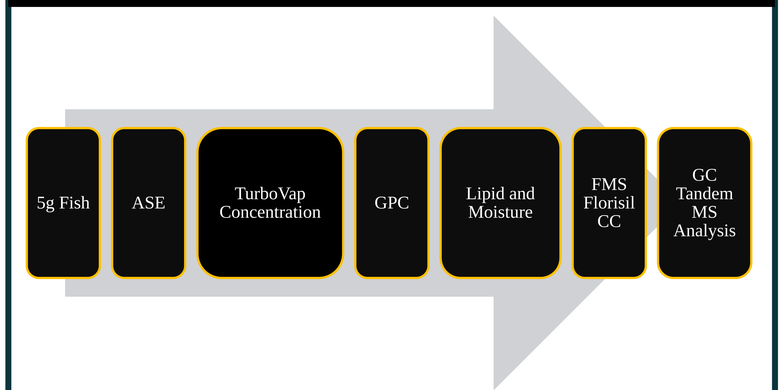
1970-1980
Fish tumors raise concern

2017
PCB contaminated soil and process materials removed

2019
EPA and Wood Inc removes heavy-metal and PCB-contaminated soil

1985-1986
Torch Lake designated Area of Concern and a Superfund Site

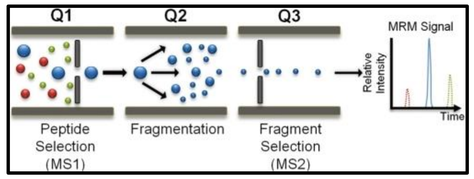
Methods



Methods Cont.

Compound classes with their own precursor – product ion pair

- Each PCB level of chlorination (10 total)
- DDT and DDD (4 total)
- DDE (2 total)
- Chlordane (2 total)
- Nonachlor (2 total)
- Oxychlordane (1 total)



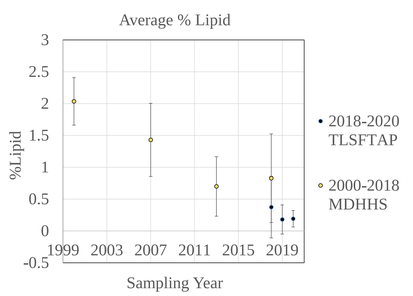
MRM Mode has three levels of identification and filtering

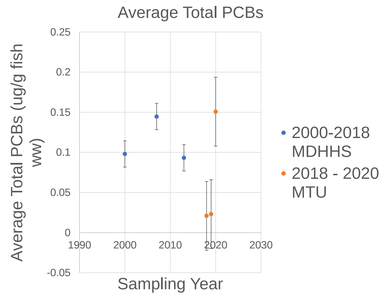
1. Retention Time
2. Precursor Ion
3. Product Ion.

The ability of a triple quadrupole to filter noise and enhance subtle ion signals enables for greater sensitivity

- More signal that we can use to quantify smaller concentrations and subtle changes in PCB, DDT, and Chlordane Concentrations

Figures and Results





Figures 1 and 2: The trends of Total PCBs from 2000-2018 and from 2018-2020 are not significantly different (t=-1.66, p= 0.051), unlike Total Chlordane (t=-5.40, p=1.55E-06) or Total DDT (-3.51, p=0.15). The Total PCB trend from 2000-2007 is not caused by fish lipid content, unlike 2007-2013. Lipid content does not explain 2013-2020, meaning that other environmental factors may contribute

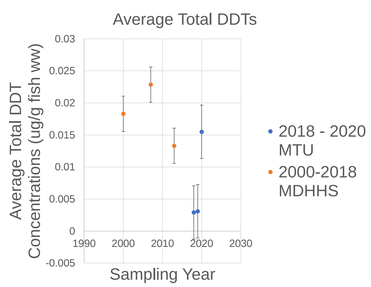


Figure 3: DDT and has a downward trend from 2000-2020. The trends before and after remediation are significantly different, unlike Total PCBs. DDT is an indicator of environmental background because there are no point sources of PCBs in Torch Lake.

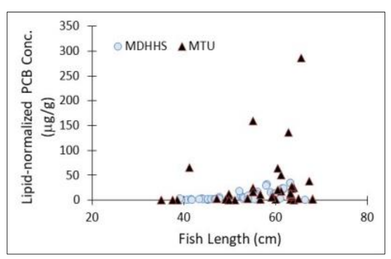


Figure 4: As fish length increases, so do the Lipid-normalized PCBs. MDHHS Values pre-remediation are comparable or lower than the MTU post-remediation values.

Figures and Results cont.

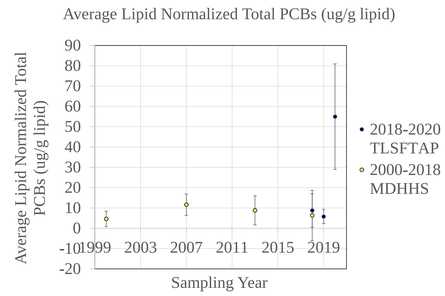


Figure 5: The trend of lipid normalized total PCBs from 2000-2018 and from 2018-2020 are significantly different. The high 2020 value could be attributed to the higher lipid content, length, and age of the 2020 subset. The fish in Torch Lake have not been restocked in several years, which means that the fish will be on average older with larger contaminant burdens that can not be diluted easily by growth.

Conclusions

The PCB trends of the walleye in Torch Lake AOC indicate that recent remediation efforts are not the main determinant, bit rather other confounding environmental factors, such as lipid content, weight, age, length, or diet could better explain the observed trends.

Overall, the PCB concentrations on average within the walleye of Torch Lake AOC have not changed much, while DDTs and Chlordane have a statistically significant decline between 2000-2018 and 2018-2020, which are indicative of environmental, not remedial effects.

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